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Lubricating Grease in Ordnance

By Lt. Col. C. E. Cummings, Ordnance Dept.—Tank-Automotive Center
Presented before the 11th Annual Meeting National Lubricating Grease Institute

1. The Ordnance Department is charged among other things with the design, development, procurement and maintenance of the Army's weapons, combat vehicles and ground transport equipment. This encompasses a range of mechanisms ranging from a simple bolt action rifle to a modern automatic anti-aircraft gun; from a "Jeep" to a 60-ton land battleship; all of which require lubrication.

2. The specification of Ordnance lubrication is further complicated by the necessity for all equipment to function reliably in rain, surf and dust; and in the heat of the desert and the cold of the sub-arctic regions. Aircraft weapons, particularly, must not shed their lubricant at ground heat; yet must operate with unfailing precision minutes later at minus 60 or lower at high altitude. Therefore, as in industry, grease is an essential element in the proper maintenance of the equipment for efficient military operations.

3. There are very few problems of lubrication technology in the Army which do not have their counterpart in civilian applications. However, the coordination of lubrication practice with the organization of the Armed Forces *is* a problem and a serious one. The sole mission of an Army is to destroy the enemy, and all of its technical adjuncts must therefore be organized for speed, reliability and ease of supply. As a result maintenance lubrication must be fitted to the proven principles of Army organization. The effectiveness of the *grease* gun, as with the Army's other guns, necessitates a study of the man behind the gun, the gun and the ammunition — grease.

4. Man is the fundamental instrument in war; his prime mission is combat or the supply of combat troops. The Infantryman must clean and lubricate his own small arms — the tank crew has no service station attendant to "give her a grease job", and consequently the routine maintenance must be simple, both in operation and supply, to insure its speedy execution, thus conserving time and energy. Successful training of military personnel involves in part the reduction of the sustaining operations to a simple, well defined routine which becomes second nature. Then in the stress of combat or emergency, the individual automatically cares for himself and his equipment, leaving his mind and initiative free to meet the exigencies of the moment.

5. The Army maintenance operations are organized in an echelon system closely following the tactical and administrative organization of the forces into Armies, Corps, Divisions, Regiments and Companies. Five steps or echelons of maintenance are designated, and a brief description of the functions of each is given in Figure 1 (slide) for the vehicles of an Infantry Division. The exact functions of each echelon will vary in accordance with the equipment in the unit, but in all cases, the great majority of the preventative maintenance lubrication is done in the first and second echelons. This is highly significant as it means that the bulk of the greasing is to be done within the company under the general supervision of the company motor officer; with only such tools and supplies as the company carries and with personnel whose prime function is not lubrication or maintenance.

6. The grease technologist, the lubrication engineer and the Ordnance designer can therefore greatly influence the efficiency of the fighting forces by combining their efforts toward making the military equipment simple and easy to service; providing compact, efficient lubricating equipment, and designating the minimum number of products to serve the requirements. In the discussion which follows, a brief review will be made of the progress in this field.

7. Less than a year ago, six different types of lubricating fittings were used on Ordnance material. As many as three of these types were being installed on some pieces of equipment, such as tanks. Each type of fitting required the use of a special coupler to contact it, and, in many cases, the additional use of special hose, swivels and attachments were needed on the grease gun. This confused situation arose from the hasty transition from experimental status to all-out production;—little of our fighting machinery having been standardized from the military maintenance standpoint. Instead, it was the quickest effort of our Automotive and allied industries, each adapting his own commercial product being delegated the hasty design and production of some new item. As a result, it would not be surprising to find tanks with tractor type button head fittings on the suspension, hydraulic type on the power plant accessories and possibly a push type fitting on the gun mount.

8. Which of the various available fittings would serve as a universal standard for all lubrication points on jeeps, tanks, artillery and the myriad of special equipment items? A large portion of the equipment being built used the standard hydraulic fitting, however, experience had shown it to be undesirable for some applications, such as track suspension systems. The prob-

Echelon System of Maintenance

INFANTRY DIVISION

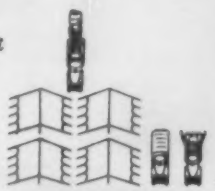
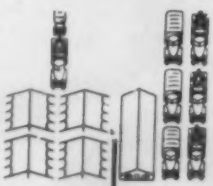
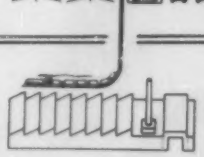
FIRST ECHELON (COMPANY)		A vehicle in combat service receives prescribed daily and weekly preventive maintenance from the driver and assistant driver...
SECOND ECHELON (COMPANY)		...with more thorough preventive maintenance monthly from the company mechanic, who also makes minor repairs and adjustments.
SECOND ECHELON (BATTALION OR REGIMENTAL)		Semi-annually it receives preventive maintenance from the battalion or regimental mechanic, who has more equipment and a little more time to use it.
THIRD ECHELON LIGHT MAINTENANCE (DIVISIONAL)		If major repairs are found necessary, recovery truck from the Ordnance light maintenance company hauls it back to the light maintenance mobile repair shop in the division bivouac area for replacement of the defective unit.
THIRD ECHELON MEDIUM MAINTENANCE (CORPS OR ARMY)		If time and facilities here are not enough for the job, a recovery truck from the Ordnance medium maintenance company (corps troops) hauls it back to a larger medium maintenance semi-mobile repair shop. Here, unit assemblies may be replaced and small accessory assemblies may be overhauled
FOURTH ECHELON HEAVY MAINTENANCE (ARMY)		If the vehicle's condition is very bad, a recovery truck from the Ordnance heavy maintenance company hauls it back to the heavy maintenance semi-mobile repair shop in the army service area. There its usable parts and assemblies are combined with those of other disabled vehicles in a process called 'cannibalizing,' by which serviceable vehicles are created.
FIFTH ECHELON (MOTOR BASE)		Finally, the faulty assemblies replaced by third and fourth echelons are shipped to the motor base in the communications zone or zone of the interior for precision production-line rebuilding. They will then be sent back to the third and fourth echelons for repair of other vehicles.

FIG. 1

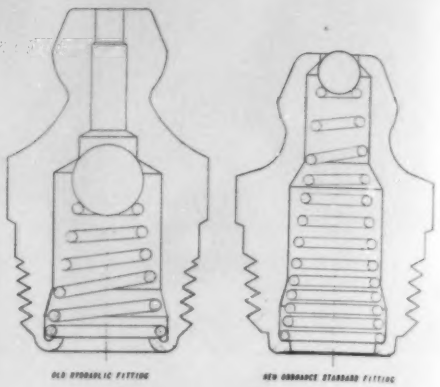
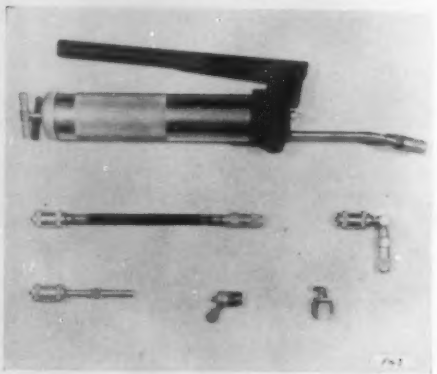
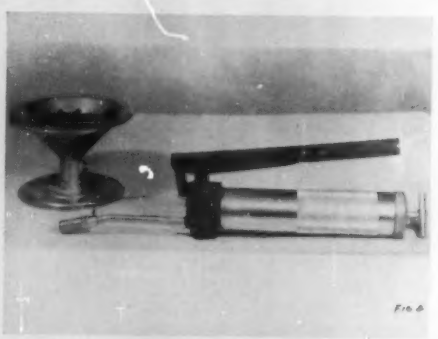


FIG 2





lem was put to the Industry, and, after much cooperative effort the Ordnance Lubricating Fitting CLDX6 (Fig. 2) was developed, service tested by all branches and adopted this year.

9. Any universal device for widespread application is necessarily a compromise in some details, and CLDX6 is no exception. It does have the decided advantage of interchangeability with the old standard hydraulic fitting which is on about 75% of Ordnance material, in that the old hydraulic couplers will fit equally well. The lower height, sturdier construction, lower restriction and better dirt exclusion features, together with the advantages of the hydraulic fitting principle were the deciding factors in adoption of CLDX6.

10. Since every piece of equipment in combat must receive its first echelon main-

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Editor's Note

The article Fatty Acids by A. C. H. Reimold appeared in the October and November 1943 issues of *Institute Spokesman* through the courtesy of Canadian Chemistry & Process Industries.

tenance from the personnel assigned to it, suitable tools must be provided. Formerly as many as 35 different types of lubricating guns were supplied for all echelons—as a result of the individual equipment manufacturer's commercial practice, the preference of the particular Army design agency, or the judgment of the various Services' maintenance groups. This condition was just about as intolerable as having a like number of different rifle models.

11. The first item to receive attention was the hand grease gun, which must be a part of the OVM (On Vehicle Material) for each vehicle, be it combat or transport type. After extensive study and testing, a standard hand lever gun, C144803 (Fig. 3) was adopted for the majority of Ordnance uses. It is a ruggedly built version of the familiar suction filling, high pressure plunger discharge type, designed to operate up to 8,000 lb. against frozen joints, and is tested at much higher pressures. Its capacity is 1 lb. and it can be quickly filled through the hydraulic fitting on the head from a power or bucket pump. To meet the needs of the various older vehicles, adapters are furnished for push type, pin type and button head fittings, in addition to angle and flexible extensions.

12. A small (3 oz.) push type gun, designed primarily for compactness, is supplied for motorcycle equipment. A larger (8 oz.) push type gun is now a standard "on carriage item" for artillery. For ball and roller bearings, a packer (Fig. 4) is now being standardized. This tool is to be used with a pressure gun, will service the majority of bearing sizes and should sup-

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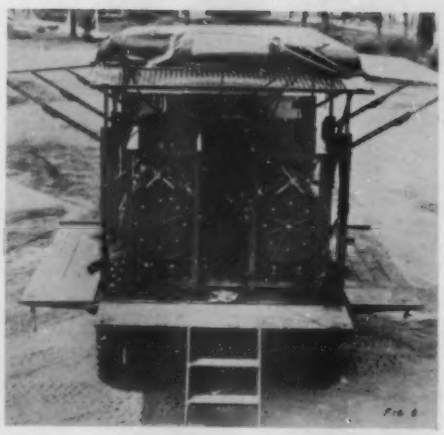
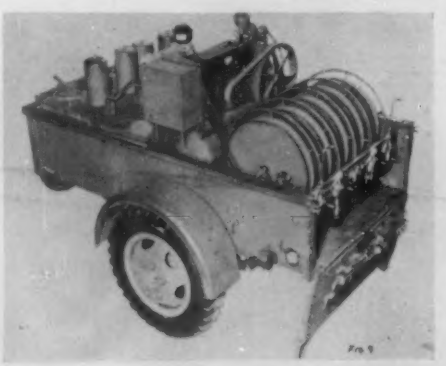
13. The lever gun, packer, low pressure pumps for gear case lubrication, and hand oilers are combined in a convenient kit (Fig. 5) for second echelon maintenance by the company mechanics. Provision is made in the kit for a supply of replacement fittings, and a complete set of adapters is included so a complete lubrication job can be accomplished on any item of equipment.



14. To further expedite the greasing of the company vehicles, a high pressure bucket pump (Fig. 6) is now being provided. It is designed to deliver grease at 8,000 lb. pressure from original 25 lb. shipping containers and is assigned primarily to the second echelon or company mechanics for use during periods when the equipment can be assembled in small groups or inactivated for periodic inspection. A similar low pressure bucket pump is provided for gear lubricant. For higher echelons, an air operated high pressure bucket pump is being studied.



15. The adoption of all items of lubricating equipment are the result of careful consideration of size, weight, simplicity and mobility. Service testing for suitability, reliability and durability is conducted by the proving grounds and the various service boards. Not the least of the requirements is that of functioning satisfactorily with winter grade chassis lubricant at a temperature of 20° below zero. Final approval and standardization must be concurred in by all branches of the Service.

16. Much study and experimentation has been expended on mobile lubrication units. The most elaborate assembly was a 2½ ton truck carrying an engine driven air compressor and battery charger, and air operated lube oil, gear oil and grease dispensers with hose reels. Figs. 7 and 8 show another version as mounted on a 1½ ton 4x4. It was proposed to employ this type unit with a special crew to move down a line of vehicles doing a production type job. However, the times when vehicles are lined up in sufficient quantity to warrant this procedure, are rare indeed in a theater of operation. Trials of the proposed outfit on maneuvers resulted in discarding the idea.

17. A more compact trailer outfit (Fig. 9) proved somewhat more practical than the truck. This unit mounted compressor, two grease dispensers and one gear oil dispenser, with one spare grease dispenser and two spare containers. Again, its utility depended upon a large assemblage of equipment and required a prime mover to tow it about the motor park, hence was not adopted as regular issue. A compact "Wheelbarrow" outfit seemed like a good compromise, since it could be moved by one man, and its size and capacity were more nearly matched to the average assemblage of vehicles in the rear echelons. This carries a gasoline engine driven air compressor and two air operated grease dispensers. The "Wheelbarrow" unit is still being studied, but its range of application appears to be limited.

18. Consideration of more or less elaborate power grease dispensing equipment must take into account several inescapable facts. Elapsed time to do a servicing job is usually more important than man-hours, since manpower is abundant and equipment must ever be on the alert. On the other hand, crew fatigue is a serious item—just riding all day in a tank requires considerable physical endurance, even without the stress of combat, hence maintenance operations by the crew should be kept to a mini-

BASIC GREASES
(Q. M. ISSUE)

SYMBOL	PRODUCT	SPECIFICATION	GENERAL APPLICATION	CHARACTERISTICS: SOAP	OIL: VISCOSITY, S.U.	OIL: POUR	OIL: FLASH	OIL: CONTENT	WORKED PENETRATION	WATER CONTENT	ASH AS SULFATES
CG	GREASE, GENERAL PURPOSE, NO. 0	U.S.ARMY 2-106	CHASSIS LUB. WINTER	CA OR AL	275-325 SEC @ 100°F 75000 SEC @ 0°F MAX	-15°F MAX	350° MIN	90% MIN	355-385	1.5% MAX	3.5% MAX
CG	GREASE, GENERAL PURPOSE, NO. 1	U.S.ARMY 2-107	CHASSIS LUB. SUMMER	CA, AL OR NA	750 SEC @ 100°F MIN		350° MIN	85% MIN	310-340	2.0% MAX	3.5% MAX
WB2	GREASE, GENERAL PURPOSE, NO. 2	U.S.ARMY 2-108	WHEEL BEARINGS	NA OR CA*	75-100 SEC @ 210°F	25°F MAX	350° MIN	82% MIN	265-295	1.5% MAX	6.0% MAX
WP	GREASE, WATER PUMP	U.S.ARMY 2-109	WATER PUMP LUBRICATION	CA	100 SEC @ 100°F MIN		315° MIN	65% MIN	175-205	2.5% MAX	8.0% MAX

* DROPPING POINT, 250°F. MIN.

FIG 12

PRINCIPAL SPECIAL GREASES

SYMBOL	PRODUCT	SPECIFICATION	APPLICATION	CHARACTERISTICS
BR	GREASE, BALL & ROLLER BEARING	NONE	CLUTCH PILOT BEARING	WIDE TEMPERATURE RANGE, HIGH STABILITY. SERVICE TEST REQUIRED.
GL	GREASE, LUBRICATING, SPECIAL	AXS-637	INSTRUMENTS	SPECIAL LOW TEMPERATURE. 300° F DROPPING POINT, 200 WORKED PENETRATION. N. H. BOMB TEST REQUIRED, ALSO COLD TEST AND SERVICE TEST. MOISTURE RESISTANT.
OG	GREASE, O.D., NO. 0	AXS-781	ARTILLERY - SUMMER	190° DROPPING POINT, 370 WORKED PENETRATION, - 40° BEARING TORQUE TEST. MOISTURE RESISTANT.
OG	GREASE, O.D., NO. 00	NONE	ARTILLERY - WINTER	"SEMI-FLUID" SERVICE TYPE COLD TESTS REQUIRED.
GM	GREASE, SPECIAL, HIGH TEMPERATURE	NONE	BALL & ROLLER BEARINGS AT HIGH TEMPERATURES	SERVICE TYPE TESTS REQUIRED.
WB3	GREASE, WHEEL BEARING HEAVY DUTY	U.S.ARMY 2-110	WHEEL BEARINGS UNDER EXTREME HEAT	NA, BA OR CA SOAP; 70% OIL OF 75 SEC. SUV @ 210° F., 350° F. FLASH; 220-250 WORKED PENETRATION, 300° F. DROPPING POINT.

FIG 13

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mum and made as easy and simple as possible. Probably the greatest consideration is necessity for dispersal of all equipment and personnel in the forward areas, to provide against undue losses from air attack. Even light and medium Ordnance maintenance companies will be found well scattered, preferably under cover in a wooded area. This requirement is not conducive to stream-lined production techniques. Above all, simplicity should be a final criterion; adding more machinery means more maintenance, spare parts, and training to an Army already so highly mechanized that it is straining our resources and ingenuity to keep a relatively small group of combatants adequately supplied.

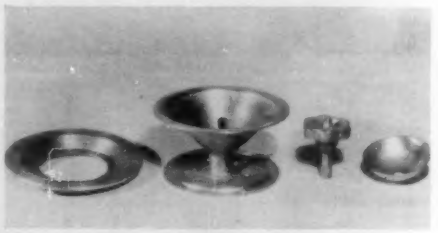
19. The Armored Board was recently asked what was now most desired in the way of improvement in grease and its application. Without any equivocation, the prompt answer was *"One grease, all purpose, all season, to simplify application and supply.* Then the soldier can just be instructed to grease equipment, and there will be no question about having a supply of the correct material and no worry about getting the right grease in the right spot." Much has already been accomplished toward simplifying the grease program, for at present the basic greases are four in number, as shown in Fig. 12. Certainly there appears to be little chance of reducing this list in the near future, although the problem constitutes a challenge to the grease technologist.

20. The principal special greases are shown in Fig. 13. The heavy duty wheel bearing grease has proved largely unnecessary and procurement of the item is small, however, at the time the basic Army specifications were written, commercial experience indicated probable need for such a product. It would seem logical to attempt a reduction of types by combining the O.D. No. OO with the "special" since both are light greases for low temperatures. O.D. No. O might be eliminated if the Artillerymen could be convinced that the specifications for general purpose No. 1 were applicable. Likewise, it appears that one grease could readily be made to meet the "ball and roller bearing" and the "special, high temperature" requirements. Thus, the special list of six could logically be reduced to two without many concessions. As may be suspected, the present list is the result of peace-time designs, when funds for development were nil, the salesman always had a special product to fit.

21. Unfortunately, there is a deeper reason for the "nones" in the specification column. The Automotive and Petroleum industries have provided thorough tests for insuring the Army's supply of all-purpose

lubricating oil; and the status of gear lubricant specifications is not far behind. Grease making, however, is apparently still one of the arts and its specifications to date can only be done in the most conservative traditions of A.S.T.M.

22. The Coordinating Research Council working groups are now engaged in a comprehensive series of projects which promise data to enable a better definition of the desired properties of greases. Besides assisting in the analysis of Ordnance service data, work is actively under way on low temperature torque tests, rust inhibiting greases for storage protection, wheel bearing lubrication, the bomb oxidation test, separation tests, pumpability determinations, and



studies of water resistance, plus a number of other items. The progress being made as a result of the cooperative spirit of this group is most encouraging.

23. Having provided the necessary lubricants and adequate tools for their application, the next problem is the instruction and training of the personnel. Lubrication instruction is a vital part of the maintenance school curriculum and is conveyed by lectures and training films, with the technical manuals for the various vehicles as the final detailed guide. The Army is indebted also to the many industry representatives who have generously contributed their time and effort in giving lectures and preparing instructional data. The lubrication guide which is included with all of the more recent technical manuals is also supplied in durable form with each vehicle shipped from the factory or depot. These lubrication guides follow the successful service station method of presentation and are con-

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sidered a most vital link in the maintenance chain.

An essential feature of these guides is the code designation or symbol given each lubricant. This symbol appears on the original lubricant containers, on the lubrication guide, and all references in the technical manual. Thus the soldier becomes accustomed to thinking of O.E. as engine oil, C.G. as chassis grease, W.B. as wheel bearing grease, etc. This scheme is working successfully and is believed to have been a great aid in facilitating the training and the ultimate success of the program.

24. In addition, it is customary to apply red paint to and around the vehicle fittings so that they can be readily spotted.

25. We know that you are all anxious to assist the Army in obtaining the best possible lubrication of its equipment, thus improving its life and reliability, and bringing victory day sooner. One of the greatest contributions would be for you and your associates to thoroughly familiarize yourselves with the lubrication policies of the War Department and to adhere strictly to those instructions when dealing with our forces in the field. There is no doubt in any of our minds that in specific cases better or more suitable products could be used and better techniques employed; but to suggest this to the man in the field, whether he be an enlisted man, motor officer or the Commanding Officer, is to invite violation of Army regulations and at the very least create confusion.

26. We welcome at all times the suggestions and advice of competent observers and the organization is available for receiving and acting upon them. The Fuels and Lubricants Section of Field Service, Maintenance Branch, Office of the Chief of Ordnance at Washington is concerned with the maintenance technique and should be contacted directly in case of observed deficiencies in the field. If the matter pertains to the lubricant quality or specification, the Fuels and Lubricants Section of the Service Branch, Technical Division, Office, Chief of Ordnance, should be consulted, and if the problem is one of the vehicle or equipment design it should be promptly brought to the attention of the Engineering Section, Engineering-Manufacturing Branch, T-AC, Detroit. The corrective action in any case must emanate or be processed through one of these groups so by consulting them directly much time will be saved.

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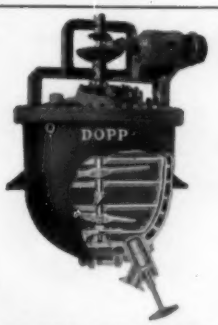

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